flow. The formula, of course, presumes that the air velocity distribution across the hood opening is uniform[3].

Example 1. A small hood 64 sq in. in area handles 400 cfm. What will be the air velocity at a point 5 in. outward along the axis if the flow is unobstructed?

Solution. Substitute in Equation 1 and solve for Y, thus

$$\frac{Y}{100 - Y} = \frac{0.1 \times 64}{5 \times 5}$$

from which $Y = 20.4$ per cent of the velocity at the opening of the hood.

$$\text{Velocity at opening} = \frac{400 \times 144}{64} = 900 \text{ fpm}$$

Hence, the velocity at the point in question is $900 \times 0.204 = 184$ fpm

Air Flow from Static Readings

The volume of air flow into any hood may be determined from the following equation:

$$Q = 4005\, fa \sqrt{h_t} \tag{2}$$

where

Q = volume of air flow in cubic feet per minute.
a = area of connecting duct in square feet.
h_t = static suction at throat of hood in inches of water.
f = orifice or restriction coefficient which varies from 0.6 to 0.9 depending on the shape of the hood.

An average value of f is 0.71, although for a well-shaped opening a value of 0.8 may be used. If it is assumed that the entrance loss of a hood is proportional to the velocity head, f can be determined by the relation:

$$f = \sqrt{\frac{h_v}{h_v + h_t}} \tag{3}$$

where

h_v = the velocity head.

For duct ends and abrupt openings $h_t = h_v$ and for flared openings $h_t = 0.5h_v$.

The term *static suction* is not a good measure of the effectiveness of a hood unless the area of the opening and the location of the operation with respect to the hood are known. This is clearly indicated by Equation 1 which shows that the velocity function at any point along the axis varies directly as the area of the opening and inversely as the square of the distance. However, this formula coupled with Equation 2 should serve to indicate the velocity conditions to be expected when operations are conducted external to the hood opening.

Large Open Hoods

Large hoods, such as used for electroplating and pickling tanks, should be subdivided so that the area of the connecting duct is not less than one-

[3]Velocity Characteristics of Hoods under Suction, by J. M. Dallavalle (A.S.H.V.E. TRANSACTIONS Vol. 38, 1932).

fifteenth the open area of the hood. Frequently, it will be found necessary to branch the main duct in order to obtain a uniform distribution of flow. *Canopy hoods* should extend 6 in. laterally from the tank for every 12-in. elevation. In most cases, hoods of this type take advantage of the natural tendency of the vapors to rise, and air velocities may be kept low. Cross drafts from open doors or windows disturb the rise of the vapors and therefore provision must be made for them. The air velocities required also depend upon the character of the vapors given off, cyanide fumes, for example, requiring an air velocity of approximately 75 fpm on the surface of the tank and acid and steam vapors requiring velocities as low as 25 to 50 fpm. The total volume of air flow necessary to obtain these velocities may be approximately determined from the following simple formula:

$$Q = 1.4PDV \tag{4}$$

where

Q = total volume of air handled by hood in cfm.
P = perimeter of the tank in feet.
D = distance between tank and hood opening in feet.
V = air velocity desired along edges and surface of tank in fpm.

Spray Booths

In the design of an efficient spray booth, it is essential to maintain an even distribution of air flow through the opening and about the object being sprayed. While in many instances, spraying operations can be performed mechanically in wholly enclosed booths, the volatile vapors may reach injurious or explosive concentrations. At all times, the concentrations of these vapors, and particularly those containing benzene, should be kept below 100 ppm. Spray booth vapors are dangerous to the health of the worker and care should be taken to minimize exposure to them.

It is recommended in the design of spray booths that the exhaust duct be located in a horizontal position slightly above the object sprayed. Stagnant regions within the booth should be carefully avoided or should be provided with a vertical exhaust. The air volume should be sufficient to maintain a velocity of 150 to 200 fpm over the open area of the booth and the vapors should be discharged through a suitable stack to permit dilution[4].

Hoods for Chemical Laboratories

Hoods used in chemical laboratories are generally provided with sliding windows which permit positive control of the fumes and vapors evolved by the apparatus. Their design should offer easy access for the installation of chemical equipment and should be well lighted. Air velocities should exceed 50 fpm when the window is opened to its maximum height.

[4]For a discussion of spray booths, see Special Bulletin No. 16, Spray Painting in Pennsylvania, Department of Labor and Industry, 1926, Harrisburg, Pa.